Sacramento Perch, Wakasagi, Splittail, Sacramento Blackfish, and Shimofuri Goby in San Luis Reservoir and O'Neill Forebay

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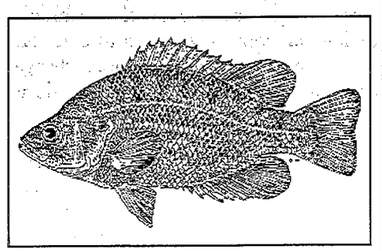
Fish sampling activities in San Luis Reservoir have supplemented USBR research in the Delta. Objectives of the San Luis research are to:

- Help us understand the effectiveness of Tracy Fish Collection Facility in protecting fish from entrainment to Central Valley Project facilities leading to San Luis Reservoir.
- Examine potential survival of fish species passing the fish facilities and arriving at the reservoir through the Delta-Mendota Canal, particularly the ecologically sensitive smelt and native cyprinids.
- Determine the ecological significance of fish species capable of self-reproduction in the reservoir.

Two trips were made to San Luis Reservoir to sample the fish community: April 20-21, 1994, and August 22-23, 1995. Areas sampled represented most of O'Neill Forebay and the Portuguese Cove arm of San Luis Reservoir (Figure 1). On the first trip, sampling gear included a half-meter plankton net, a 3-foot plankton (net) beach seine, a 10-foot (1/8-inch mesh) beach seine, and experimental gill-nets. A total of 11 fish species were captured (Table 1). On the second trip, 10-foot and 50-foot beach seines (both 1/8-inch mesh) were used to sample inshore fish fauna. A total of 21 fish species were captured in 1995. During the two field trips, 24 fish species were observed.

The most abundant fish species were inland silverside and threadfin shad. Five species of special interest are discussed below.



SACRAMENTO PERCH
From *Fishes of California* (Moyle 1976, U.C. Press.)

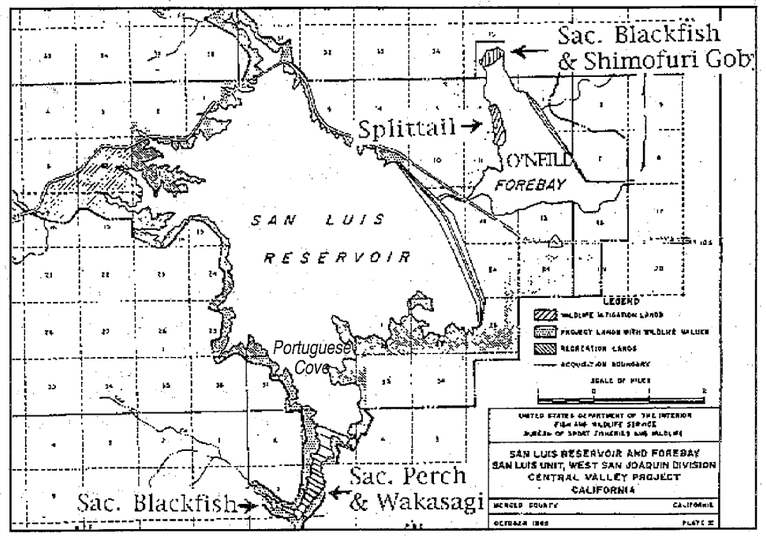


Figure 1
COLLECTION AREAS FOR SPECIAL INTEREST FISHES IN SAN LUIS RESERVOIR AND O'NEILL FOREBAY

Table 1
FISH SPECIES OBSERVED AT SAN LUIS RESERVOIR AND O'NEILL FOREBAY, 1994 and 1995.

Common Name	Scientific Name	1994	1995
American shad	*Alosa sapidissima*	+	+
Threadfin shad	*Dorosoma petenense*		+
Wakasagi	*Hypomesus nipponensis*	+	+
Goldfish	*Carassius auratus*	+	
Common Carp	*Cyprinus carpio*		+
Sacramento blackfish	*Orthodon microlepidotus*		+
Splitttail	*Pogonichthys macrolepidotus*		+
Sacramento sucker	*Catostomus occidentalis*	+	+
White catfish	*Ameiurus catus*	+	+
Channel catfish	*Ictalurus punctatus*		+
Western mosquitofish	*Gambusia affinis*		+
Inland silverside	*Menidia beryllina*	+	+
Threespine stickleback	*Gasterosteus aculeatus*		+
Striped bass	*Morone saxatilis*		+
Sacramento perch	*Archoplites interruptus*		+
Green sunfish	*Lepomis cyanellus*	+	
Warmouth	*Lepomis gulosus*	+	
Bluegill	*Lepomis macrochirus*	+	+
Largemouth bass	*Micropterus salmoides*		+
Black crappie	*Pomoxis nigromaculatus*		+
Bigscale logperch	*Percina macrolepida*		+
Tule perch	*Hysterocarpus traski*	+	+
Shimofuri goby	*Tritentiger bifasciatus*	+	
Prickly sculpin	*Cottus asper*	+	+
Total		11	21

Sacramento Perch

Sacramento perch (*Archoplites interruptus)* is the only North American native centrarchid found west of the Rocky Mountains. It is considered extirpated from its original habitat (the Sacramento and San Joaquin rivers) and has not been seen in the delta for at least a decade (Peter Moyle and Scott Mattern, personal communication). It is found in ponds in and around the delta and in a few lakes where it was introduced. The Sacramento perch's decline is attributed to the introduction of other centrarchids (sunfish and bass), which out compete it in its native habitat.

Sacramento perch was extremely abundant in beach seine collections. We preserved 77 Sacramento perch ranging from 20 to 43 mm total length, which were captured on August 23, 1995, in Portuguese Cove Arm. All specimens were young-of-the-year from the 1995 year-class and represented only a small portion of perch observed. Apparently, Sacramento perch has existed and reproduced in San Luis Reservoir for quite sometime. Since there are presently no Sacramento perch in the delta, it must have been introduced into San Luis Reservoir when the reservoir began filling in the late 1960s. At that time a small delta population still existed.

We believe successful reproduction in 1995 may have been related to the wet winter, which allowed high stable water levels in San Luis Reservoir during May and June, the perch spawning season. Drawing down the reservoir in late spring for agricultural and municipal purposes probably strands many Sacramento perch spawning nests, leaving them exposed to predation — and even out of water in drier years.

Wakasagi

Wakasagi (*Hypomesus nipponensis*) is an exotic osmerid introduced from Japan into several California reservoirs in the late 1950s. At that time it was considered to be the same species as delta smelt, but the two species have now been separated. Wakasagi is thought to have reached the Delta through an introduction into Sly Park Reservoir in the 1980s (Dennis Lee, personal communication). Wakasagi migrated through the American River drainage to Folsom Lake, where it has become abundant. Extensive dike repairs at Folsom Dam required major reservoir draw-downs, which probably enhanced the invasion of wakasagi to the American and Sacramento rivers. Wakasagi has been positively identified at the CVP/SWP fish facilities in recent years.

In April 1994, three prejuvenile and juvenile specimens (18.5 to 23.0 mm total length) were captured by plankton-net beach seining in a small retention pond on the Portuguese Cove Arm. This pond floods when San Luis Reservoir is full. On August 23, 1995, 29 larger juvenile wakasagi (64.0 to 90.3 mm total length) were collected in the retention pond and beach seine stations in Portuguese Cove. All wakasagi captured during both trips were young-of-the-year.

We believe wakasagi has established a reproducing population at San Luis Reservoir in recent years because of an apparent large wakasagi population in San Luis Reservoir, while virtually no young-of-the-year smelt were collected at the fish facilities in 1995. Reproduction in San Luis Reservoir is a more plausible explanation, rather than Delta export, for the observed wakasagi distribution and abundance.

No delta smelt or longfin smelt were collected at San Luis Reservoir during either of the two sampling trips. We believe wakasagi were successfully introduced into San Luis Reservoir, while delta smelt were not, because of wakasagi's preference for fresh water. Delta and longfin smelts seem to require more brackish water.

We expect the wakasagi population in San Luis Reservoir to continue to expand. We have not collected any wakasagi in O'Neill Forebay.

Splittail

Splitttail (*Pogonichthys macrolepidotus*) is a large native minnow that is being considered for protection under the federal Endangered Species Act. During the drought years of the late 1980s and early 1990s, splittail became scarce in the CVP fish facility salvage; about 1 million juvenile splittail were salvaged in 1993 and 3 million in 1995, both wet years.

During the 1994 survey of San Luis Reservoir, we were looking for splittail reproduction, but found none. In 1995, we wanted to document survival in O'Neill Forebay of juvenile splittail being transplanted down the Delta-Mendota Canal from the abundant splittail year class in the delta. On August 22, 1995, 26 juvenile splittail (72 to 135 mm total length) were captured near San Luis Creek boat ramp in O'Neill Forebay. We believe these came from the Delta and not from natural reproduction in the San Luis/O'Neill complex. We based this conclusion on the fact that in 1994, when splittail reproduction in the delta was low, we could not find splittail in either San Luis or O'Neill, but in 1995, when splittail reproduction was very successful in the delta, we found juvenile splittail in O'Neill Forebay. The question remains whether these juvenile splittail will stay in the reservoir or try to migrate from the system.

Sacramento Blackfish

Sacramento blackfish (*Orthodon microlepidotus*) is a native minnow that has declined substantially in the delta. Blackfish has been abundant in the San Luis/O'Neill complex and supported a commercial fishery in San Luis Reservoir.

In 1995, we collected two size classes of Sacramento blackfish in the San Luis complex. We collected several blackfish in O'Neill Forebay and preserved a single specimen (107 mm TL). We believe these fish were transported from the delta, since similar-sized blackfish were seen at the fish facilities. In addition, two small juvenile blackfish (33.1 and 47.0 mm) were collected in the uppermost section of Portuguese Cove. We believe these smaller fish were spawned in the cooler water in San Luis Reservoir and grew more slowly than delta fish.

Shimofuri Goby

Shimofuri goby (*Tritentiger bifasciatus*) is an exotic fish species introduced from Japan. It likely came into San Francisco Bay via ballast water in a freighter. There is a question whether this species can survive and successfully reproduce in fresh water.

Three juvenile Shimofuri goby (18.6 to 33.5 mm total length) were observed at the Delta-Mendota Canal's entrance to O'Neill Forebay on August 22, 1995 — the first observation of this species in the San Luis/O'Neill complex. It is not known whether these juveniles represent reproduction in O'Neill Forebay or transport from the Delta. Because of their collection location, we suspect the latter.

Conclusions

Fish whose native habitat has declined — and whose abundance has declined as a result — have colonized the habitat in at least part of the San Luis/O'Neill complex. Sacramento perch found suitable habitat in San Luis Reservoir and is an example of a native fish that expanded its range to newly created habitat. Wakasagi, a recently arrived exotic species, seems to be dramatically expanding its range and exploiting new habitat. For both fishery and water delivery managers, management implications are associated with development and potential use of new fish habitat. Additional research on the fish communities of CVP canals and reservoirs is being considered.

Brown Bag Seminar

November 20, 1995
11:30 - 1:00
Cafeteria
3251 S Street
Sacramento

Topics:

Understanding How GIS Works
GIS Applications in the Delta and Elsewhere

Featured Speakers:

Kevin Regan and Chuching Wang,
Metropolitan Water District of Southern California
Alan Kilgore (DFG) will be available to address delta GIS applications.

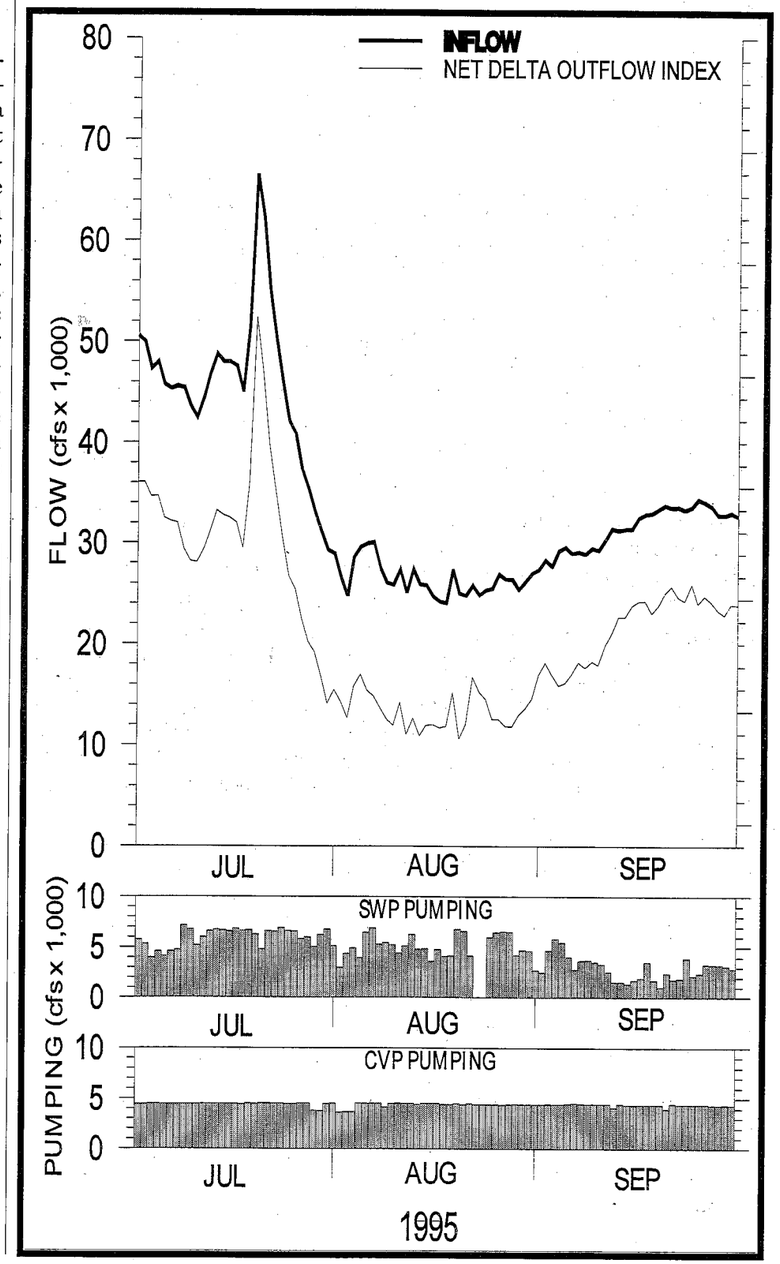
Contact:

Leo Winternitz (916/227-7548)
Karl Jacobs (916/227-0435)

Delta Flows

Kate Le, Department of Water Resources

The July-September Delta Outflow Index averaged about 22,000 cfs. During the latter part of July, peak inflow was about 67,000 cfs and peak outflow was about 52,000 cfs. These peaks are results of high flows due to the Folsom Dam gate failure. Combined SWP and CVP pumping from July through September averaged about 8,900 cfs. Since the CVP was pumping at full capacity, SWP pumping was increased to accommodate the high releases through the failed gate. SWP pumping ceased for 2 days in late August because of maintenance work.



Laboratory Culture of Delta Smelt

Serge Doroshov and Randy Mager, University of California, Davis

Wild juvenile delta smelt captured in fall 1994 were raised to maturity in laboratory tanks. They spawned in May 1995. Eggs were collected and incubated in conical glass jars with upwelling flow. Although spawning results were not entirely satisfactory (most spawnings produced infertile or low fertility eggs), we obtained several batches of eggs of high fertility and hatchability. Mortalities during rearing from juvenile to mature stage were minor, and there was no incidence of *Mycobacterium* disease. Full screen metal content analysis of rearing water was conducted to elucidate potential effect of contaminants on spawning: all metals were below detection limit, except for barium (100 ppb in rearing tank and 120 ppb in the water source, a newly built well at Institute of Ecology. There was no evidence of any toxic effect of barium at this concentration on adult broodstock, but elevated concentration of barium are known to negatively affect the fertilization success in marine invertebrates (Dr. Gary Cherr, Bodega Bay Marine Laboratory, personal communication).

Hatched larvae were raised for the first 3 weeks in static-renewal aquaria at water salinity 5-6 parts per thousand and high stocking density. The continuous culture and production of *Nanochloropsis* oculata (alga) and *Brachionus plicatilis* (rotifer) was established to maintain concentration of algae at about 250,000 cell/ mL and rotifers 10/mL in rearing containers. It was observed that phytoplankton in rearing tanks is required to stimulate feeding activity of larvae. This phase of larval rearing was highly successful: estimated survival was about 80%, and total length of larvae increased from 5 to 12 mm. At 3 weeks after hatching, larvae retained continuous finfold and did not exhibit lumenal dilation of the swim bladders.

At 3-4 weeks after hatching, larvae were transferred to larger tanks with a partial water exchange. Algae, rotifers, and brine shrimp nauplii were added daily. At this age, larvae exhibit strong preference for larger prey, consuming only brine shrimp nauplii. Despite the significant feeding activity and consumption, mortality increased, most likely due to inadequate nutritional value of brine shrimp nauplii. Attempts to use artificial diets at this stage of development failed. The available larval diets are ingested, but they leach rapidly in the water column, resulting in poor water quality. At about 4-5 weeks after hatching, larvae were about 14-15 mm tail length, had differentiated caudal and dorsal fins, and differentiated but not inflated swim bladders. At 6 weeks after hatching, larval survival in rearing tanks was 30-40%.

Larvae were sampled at about 10-day intervals, and data on growth and development will be presented. Preliminary observations suggest larval development of delta smelt from hatching to metamorphosis is generally similar to that of *Osmerus eperlanus* (Urho 1992, Baltic Sea) and likely to *Osmerus mordax* (Cooper 1978) — hatching at 5-6 mm TL; yolk resorption and first feeding at 5 days after hatching; sparse pigmentation with ventral melanophores; differentiation of dorsal, caudal, anal, and pelvic fins at 12-18 mm TL; and swim bladder filling at 17 mm.

There is an overall similarity, with regard to problems and techniques in rearing smelt larvae to metamorphosis, with larval culture of clupeoid fish reviewed by Blaxter and Hunter (1982).

This year, work suggests that laboratory culture of delta smelt is technically feasible but labor-intensive. Broodfish can be raised and spawned in captivity to obtain adequate supplies of fertilized eggs and larvae. Normal growth, development, and high survival of larvae can be maintained during the first 3 weeks of feeding. Further rearing to metamorphosis requires improvement, mainly in larval feeding techniques. Use of new larval diets with enhanced stability in water may be appropriate to pursue.

References

Blaxter, J.H.S., and J.R. Hunter. 1982. The biology of the clupeoid fishes. *Advances in Marine Biology*. J.H.S. Blaxter *et al*, editors. 20:1-223.

Cooper, J.E. 1978. Identification of eggs, larvae, and juveniles of the rainbow smelt, *Osmerus mordax*, with comparisons to larval alewife and gizzard shad. *Transactions of the American Fisheries Society*. 107(1):56-62.

Urho, L. 1992. Morphological and ecological differences in the development of smelt and herring larvae in the northern Baltic Sea. *Sarsia*. 77:1-10.

DAYFLOW Hydrologic Data

A semiannual DAYFLOW update for October 1994 through June 1995 is now available in electronic or paper copy.
The 1995 water year annual DAYFLOW update is scheduled to be available in December 1995.
Contact Sheila Greene (916/227-7538).